PTO/PCT Rec'd 10 JAN 2000

09/402049
#3

TRANSMISSION PACKETS OF THE SAME LENGTH AND OF DIFFERENT STRUCTURE

The present invention relates to transmission packets of a length that is imposed, said packets presenting different structures.

The field of the invention is typically that of digital communications making use of packet transmission for conveying information from a sender to a receiver. The case considered is that in which such a packet is formed by a training sequence and by an information sequence without prejudice as to the respective positions of said sequences in the packet. In particular, the training sequence can be at its head (in which case it is referred to as a "preamble"), however it can also appear in the middle of the packet (in which case it is called a "midamble"). The training sequence is constituted by symbols that are known to the sender and to the receiver. It is used by the receiver specifically for acquiring synchronization and for estimating the impulse response of the transmission channel connecting it to the sender. It is the estimated impulse response that enables the symbols of the information sequence to be demodulated, which symbols are assumed to be unknown.

A major example of this kind of packet is to be found in the GSM cellular digital radio system. An access packet known as "RACH" is provided which is transmitted by a terminal when it makes a connection to a network. This packet which is specified in GSM Recommendation 04.6 has a fixed length of 85 symbols or bits. It comprises a training sequence of 49 bits and an information sequence of 36 bits. The information sequence is obtained from an 8-bit word. A parity function is applied to said word and generates a run of 6 bits. An 18-bit message is obtained by concatenating the 8-bit word, the run of 6 parity bits, and 4 predetermined bits referred to as "tail" bits. The message is then subjected to convolutional encoding having a ratio of 1/2

so as to give the information sequence. The above operations for protecting the information are intended to protect the integrity of the 8-bit word from various hazards due to transmission.

Due to system development, it can happen that the capacity of a single packet, eight information bits for a RACH packet, is no longer sufficient to provide proper service. As an example of such development, it might be desirable to add data such as priority level, binary data rate required for a call, or terminal operating mode, which data does not appear in the 8-bit word as originally provided for.

It will be understood that such development must be provided at the least possible cost, i.e. by modifying the infrastructure and the terminal both in hardware terms and in software terms as little as possible. Thus, the natural approach consists in retaining the structure of the packet, i.e. the training sequence and the total length of the packet which result from technical constraints that are directly tied to the system. On these lines, various solutions are available for increasing the capacity of the packet, e.g. by extending it from 8 bits to 11 bits, but without changing the total length of the information sequence, which is 32 bits in the present case.

A first solution consists in adopting a novel code for producing a 36-bit sequence from the 11 information bits. That solution is unsatisfactory since it requires a novel encoder in the sender and a novel decoder in the receiver.

A second solution is discussed in document "TDoc SMG2 GPRS 116/96" presented to the ad hoc ETSI SMG2 GPRS meeting held in Stockholm on October 16 to 18, 1996. According to that document, a parity function expressed on 6 bits is again used, together with the four tail bits which are placed after the 11 information bits so as to constitute a 21-bit message. The message is applied to

the same convolutional encoding as was used for the 8-bit word so as to obtain an information sequence of 42 bits. It is thus necessary to shorten this 42-bit sequence to a 36-bit sequence so as to enable it to be inserted in the packet. To be able to do this, a technique known as "punching" is used, i.e. 1 bit is eliminated every 7 bits of the information sequence. That solution has the advantage of minimizing modifications at the sender. However, on reception, it is necessary to reinsert the 6 bits that have been eliminated by assuming that both possible binary values are equally probable for each of said bits, and it is necessary to do this prior to decoding. As a result, the performance of the code designed to enable transmission errors to be corrected is degraded, thereby leading to a deterioration in error rate on reception.

A third solution is described in the document "TDoc SMG2 GPRS 170/97" given to the ad hoc ETSI SMG2 GPRS meeting at Stuttgart on January 22 to 24, 1997. According to that document, a 6-bit parity function is used again, but only one of the originally-provided four tail bits is retained, thereby obtaining an 18-bit message to which the conventional convolutional encoding is applied in order to generate a 36-bit information sequence. That sequence improves the error rate compared with the error rate that is obtained by using the preceding solution, however eliminating 3 bits from the tail also perceptibly degrades the performance of the error-correcting code.

An object of the present invention is thus to provide a packet of a second type which is compatible at transmission level with a packet of a first type as defined above, said second type of packet presenting greater capacity than the first, and being designed to minimize the modifications made to the various pieces of equipment and to degrade reception performance as little as possible.

According to the invention, apparatus adapted to sending transmission packets of predetermined length, the apparatus comprising formatting means suitable for formatting a first type of packet on the basis of a first training sequence and of a first information sequence is distinguished in that in order to send a second information sequence longer than the first information sequence, said formatting means are also designed to format a second type of packet on the basis of a second training sequence that is shorter than the first training sequence, and of said second information sequence, said means formatting a packet whose type is identified by an identification signal.

Similarly, the invention provides apparatus adapted to receiving transmission packets of predetermined length; a received packet being either of a first type or of a second type, and comprising a respective first or second training sequence together with a respective first or second information sequence, the second information sequence being longer than the first information sequence, the apparatus comprises means for isolating the information sequence of said received packet in response to a selection signal identifying the type of said packet.

Under such circumstances, the information sequence is given priority to the detriment of the training sequence. The information sequence of a packet of the second type is sent without alteration so, on this point, the performance obtained using a packet of the first type is retained. It is true that shortening the training sequence gives rise to drawbacks, essentially to an increased risk of a packet being wrongly detected (the receiver deems that a packet has been received when this is not so), and an estimate of the impulse response of the transmission channel that is of poorer quality, given that the estimate is established on the basis of a smaller number of bits. However, the training sequence

is generally dimensioned very generously so as to ensure optimum receiver operation. Thus, performance is affected in negligible manner if shortening this sequence remains within acceptable limits. Overall, the packet of the second type provides the desired service under conditions that are acceptable.

Furthermore, the apparatus adapted for sending comprises single encoding means to produce said first and second information sequences respectively from first and second messages.

Similarly, in the apparatus adapted for receiving, since the information sequences of the different packets result from encoding of the same kind, the apparatus comprises single decoding means for decoding both said first and said second information sequences.

By adopting the same code for both types of packet, modifications to the sender and to the receiver are limited.

The invention applies essentially when the second information sequence contains more information than the first information sequence.

In a first option, the second training sequence corresponds to a subsequence of the first training sequence.

Thus, and advantageously, when the second training sequence corresponds to a subsequence of the first training sequence, the apparatus adapted to receiving comprises single demodulator means for demodulating packets of both types.

This also serves to limit modifications to the receiver.

In a second option, the second training sequence of length *l* is substantially orthogonal to subsequences of length *l* of the first training sequence.

In which case, the risk of interference between two packets of different types is considerably reduced,

assuming that such packets happen to be transmitted at the same instant.

The present invention will appear in greater detail from the following description of an embodiment given by way of illustration and with reference to the accompanying figures, in which:

· Figure 1 shows apparatus adapted to sending a packet of the second type in accordance with the invention; and

· Figure 2 shows apparatus adapted to receiving the same packet.

Elements present in both figures are given the same references in each of them.

The invention thus provides for two types of packet that are compatible at transmission level, i.e. they are of the same length.

With reference to Figure 1, apparatus is provided to enable a first 8-bit data word W1 to be conveyed by means of a transmission packet of a first type. This first word W1 is applied to a first processor module P1 which calculates a parity function that is expressed on 6 bits on the basis of the 8 bits of said data word. This module concatenates the 8-bit word, the six parity bits, and four predetermined "tail" bits to form a first message M1.

In analogous manner, a second data word W2 having a 11 bits is designed to be conveyed by means of a packet of a second type. When transmitting such a packet, the second word W2 is applied to a second processor module P2 which calculates another parity function that is likewise expressed on 6 bits. The second module concatenates the 11-bit word, the six parity bits, and the above-mentioned four tail bits so as to form a second message M2.

A control circuit (not shown) of the sender for which the apparatus is intended produces an identification signal Id which specifies to said

apparatus whether it is to process a packet of the first type or of the second type.

The apparatus thus also comprises an encoder unit COD which selects the first message M1 or the second message M2 depending on the state of the identification signal Id and produces a corresponding first or second information sequence IS1 or IS2 by means of a convolutional code having a ratio of 1/2. By way of example, this unit may be in the form of a circuit that is dedicated to the encoding operation. Furthermore, the person skilled in the art will understand that this is merely a preferred embodiment of the invention and that the invention applies equally well if the encoding applied to the two messages M1 and M2 is different.

The apparatus also has a formatting unit F. When the identification signal ID specifies that the packet to be sent is of the first type, this unit juxtaposes a first training sequence TS1 that is 49 bits long to the first message M1 that is 36 bits long coming from the encoding unit COD so as to produce a packet of the first type B1. If the identification signal ID specifies that the packet to be sent is of the second type, the formatting unit F juxtaposes a second training sequence TS2 that is 43 bits long with the second message M2 that is 42 bits long coming from the encoding unit COD so as to produce a packet of the second type B2.

The invention also provides another apparatus for processing packets as received in a receiver whether they be of the first type or of the second type.

With reference to Figure 2, this apparatus comprises a detector unit D which receives a packet B whose type is identified by a selection signal Sel.

The signal Sel is delivered by a control unit (not shown) of the receiver in which the apparatus is included. By way of example, the control unit associates packets received over a first channel with the first type

and packets received over a second channel with the second type.

The detector unit D proceeds in conventional manner with correlating the received packet with the first or second training sequence TS1 or TS2 depending on whether the selection signal Sel identifies the packet as being of the first type B1 or of the second type B2. This correlation operation serves in particular to acquire synchronization, i.e. to identify within the received packet the received sequence which corresponds to the information sequence as formatted for sending. This unit addresses the sequence S1 received from a packet of the first type B1 to a first demodulator DEM1 or the sequence S2 received from a packet of the second type B2 to a second demodulator DEM2. Advantageously, the detector unit also estimates the impulse response of the transmission channel so as to transmit it to the corresponding demodulator depending on the type of packet received. This estimate is performed, for example, using the known "least squares" technique.

Each of the first and second demodulators DEM1 and DEM2 serves respectively to deliver a first or second information sequences IS1 or IS2 based on the corresponding received sequence S1 or S2.

The apparatus essentially comprises a single decoder unit DEC since in the present embodiment, the same code is used for both types of information sequence. This unit thus receives a first or a second information sequence IS1 or IS2 and delivers a first or a second message M1 or M2, respectively. Depending on circumstances, a first or a second data word W1 or W2 is reconstructed respectively from a first or a second message M1 or M2 using methods that are well known to the person skilled in the art.

A preferred embodiment of the invention consists in selecting the second training sequence TS2 as corresponding to a subsequence of the first training

sequence TS1, i.e. in the present example, by eliminating from said first sequence TS1, the first 6 bits, the last 6 bits, or more generally the n first bits and the (6-n) last bits when n is an integer lying in the range 0 to 6. In this case, the detector unit D correlates the received packet with the first training sequence TS1 regardless of the type of packet that has been received. It is also possible to use the same demodulation techniques regardless of whether the packet is of the first type or of the second type. This solution presents the advantage of minimizing the modifications that to be made to the receiver, and it is particularly recommended when the loss of performance that results from applying it remains acceptable.

Another embodiment presents specific advantages when it might happen that packets of both types coexist in the system in which the invention is applied. Under such circumstances, it is possible to select a second training sequence TS2 of length *l* such that it is substantially orthogonal to the various subsequences of length *l* of the first training sequence TS1. By acting in this way, difficulties due to possible interference between a packet B1 of the first type and a packet B2 of the same type are minimized.

The embodiments of the invention as described above relate to two types of packet having different capacities, i.e. made up of data words having different lengths. This should not be seen as being a limit on the invention. By way of example, mention can be made of the case in which a packet of the first type as originally provided for by a system turns out to be unsuitable for correctly performing the intended service because the protection system (the parity bits, the tail bits, and the convolutional code) does not perform the function it is supposed to perform with satisfactory security. It would then be desirable to increase the protection given to the data word by means of additional bits. That

amounts to increasing the corresponding information sequence without changing the data word.

The present invention can thus be implemented in a wide variety of ways that cannot all be listed exhaustively.